Comparing Sedflux Predictions to Geoacoustic Data

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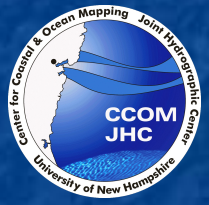

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Outline

1) Summarize SedFlux ⇒ geoacoustic properties modeling

2) Describe geoacoustic measurement techniques
   - in-situ probe measurement technique (Vp, α)
   - wide-angle reflection technique (Vp(z), r(z), α(z))

3) Compare SedFlux geoacoustics with measured data (compressional sound speed)

Geoacoustic Properties

SedFlux

Grain Size Distribution

Empirical Models

Porosity

Bulk Density

Permeability

Buckingham Model

Compressional Velocity

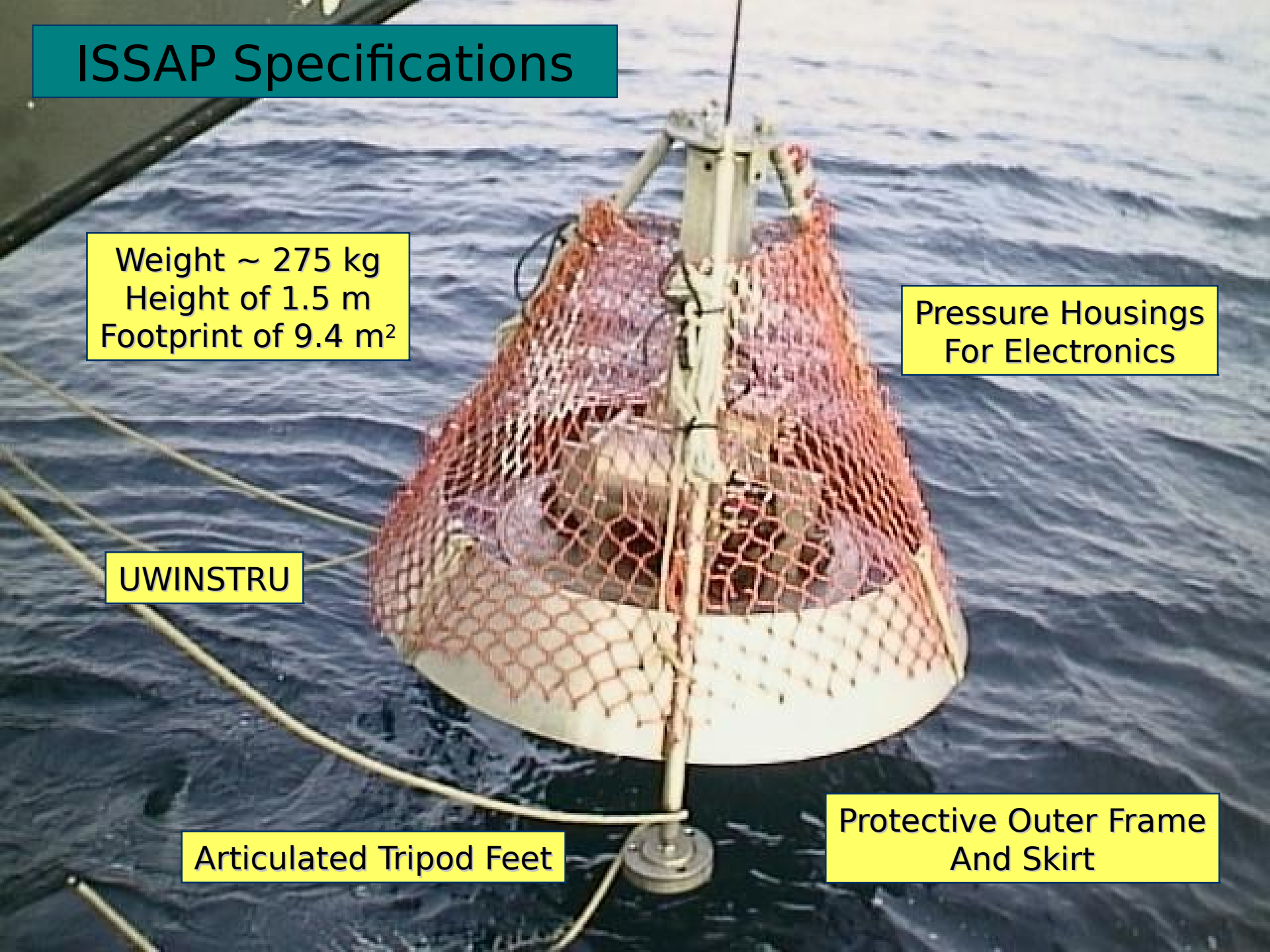
Compressional Velocity

EDFM

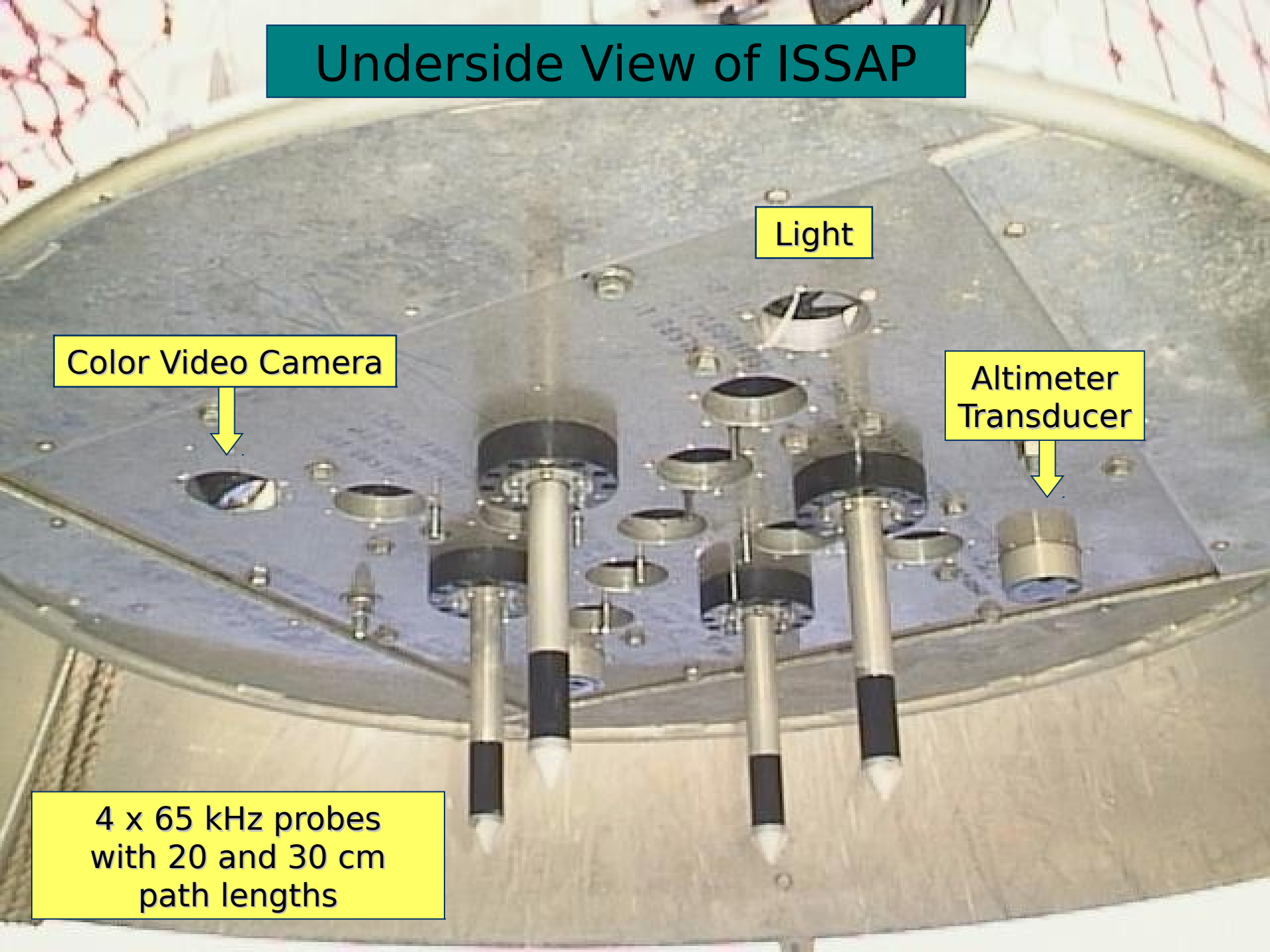
[1] Buckingham, M J.. "Theory of acoustic attenuation, dispersion, and pulse propagation in unconsolidated granular materials including marine sediments," J. Acoust. Soc. Am., **102**, 2579-2596 (1997)

[2] Williams, K. L., "An effective density fluid model for acoustic propagation in sediments derived from Biot theory," J. Acoust. Soc. Am., **110,** 2276-2281 (2001)

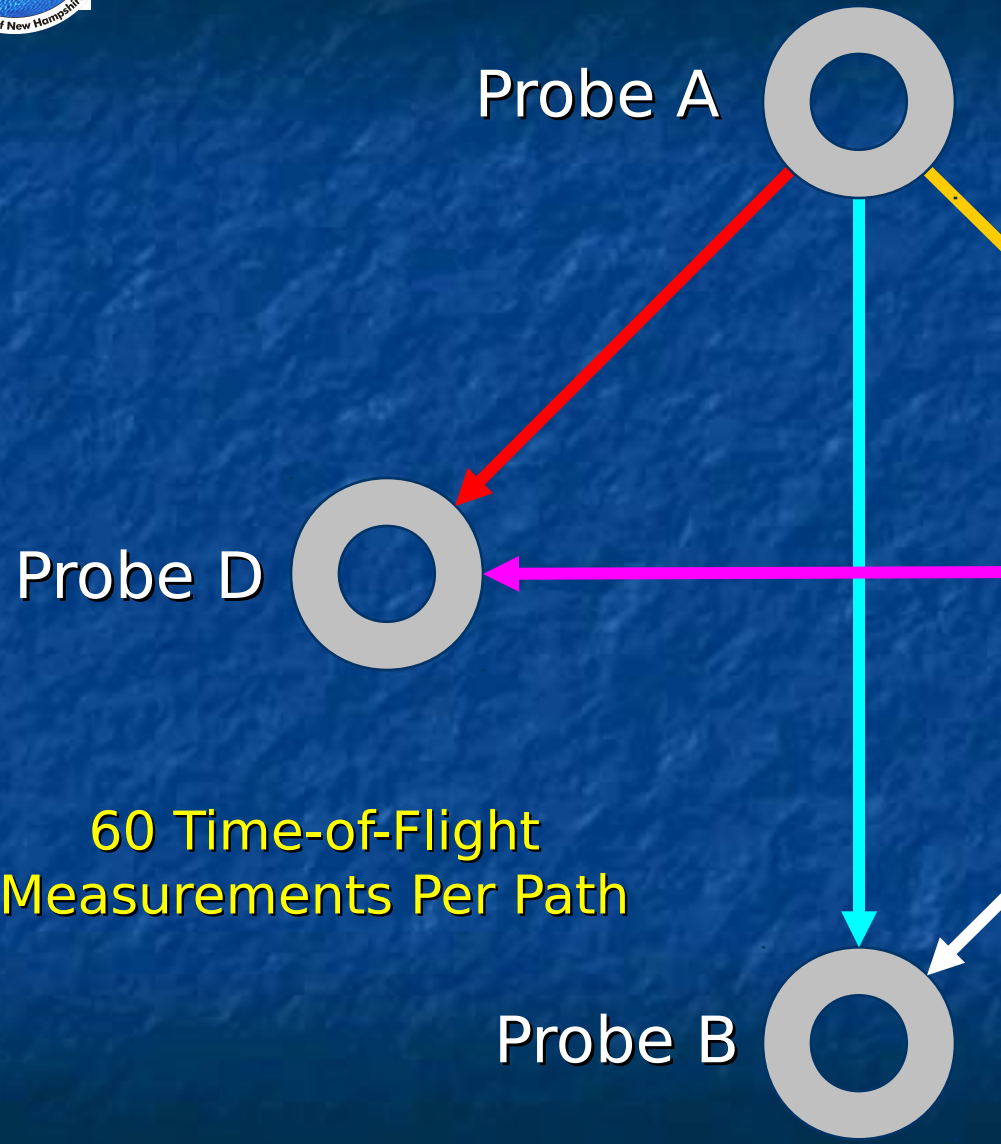
ISSAP Specifications



Underside View of ISSAP



ISSAP Probe Layout



Trigger Frequency

30 Hz

60 Time-of-Flight Measurements Per Path

Trigger Sequence

Path AB

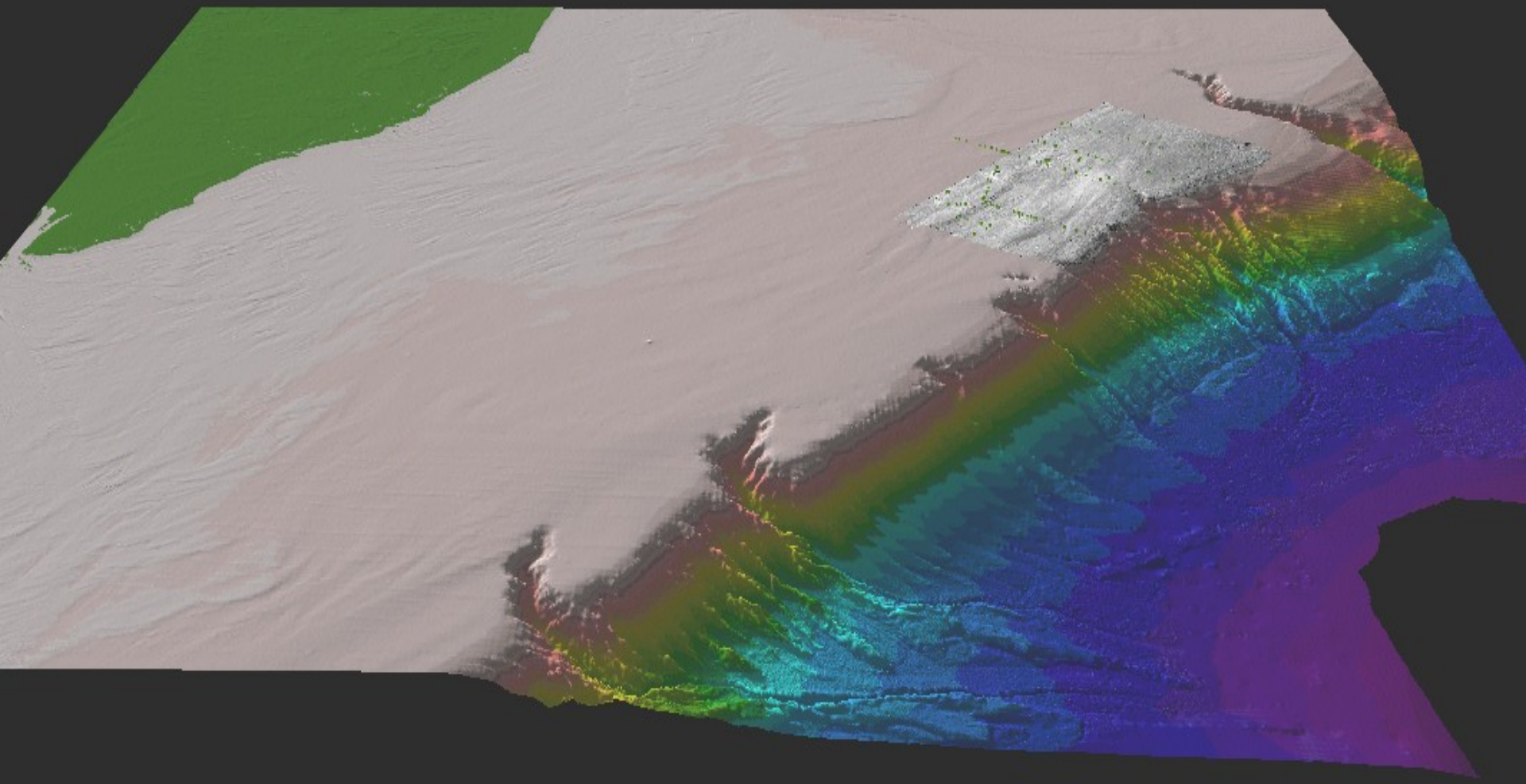
Path AC

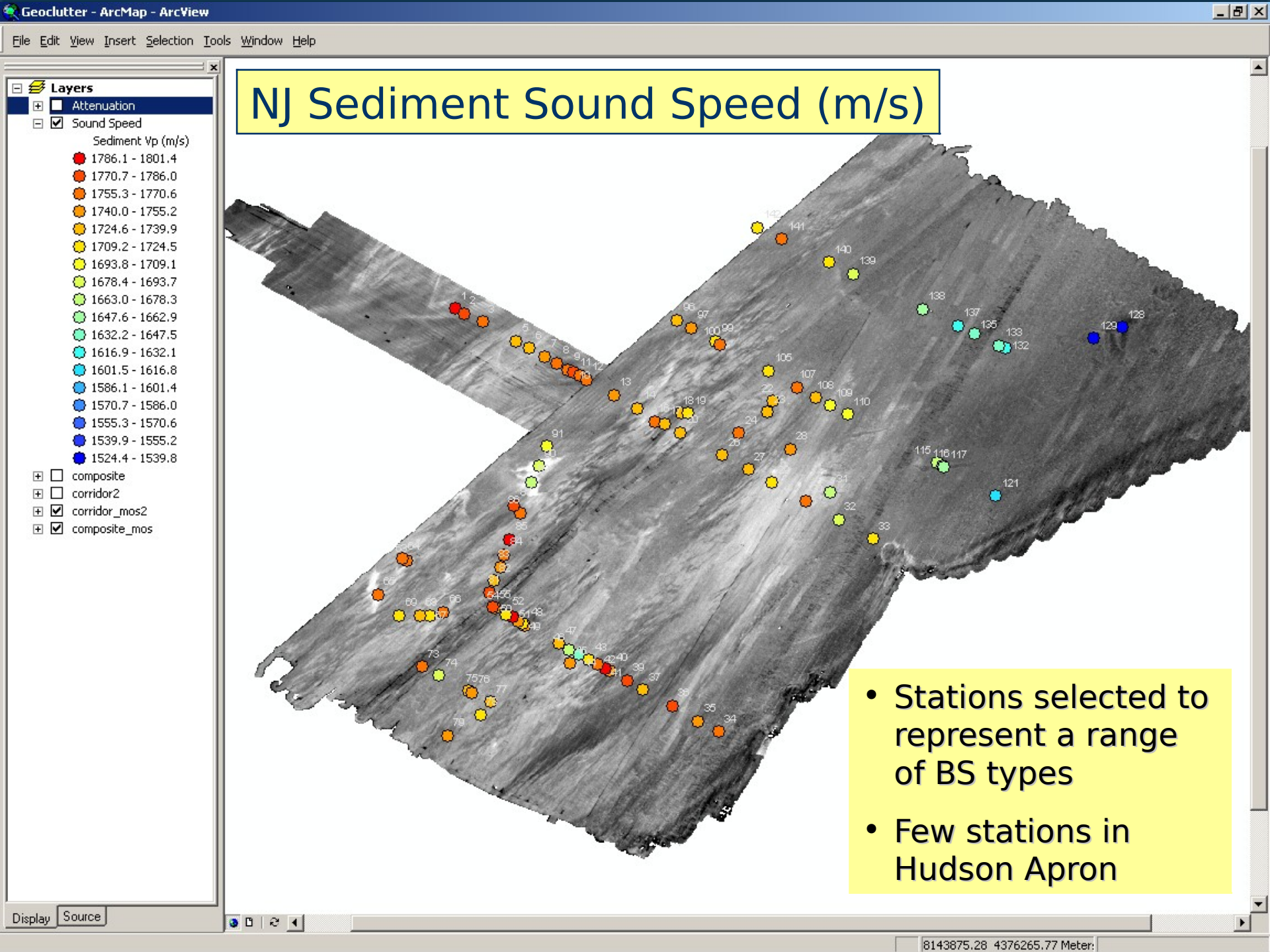
Path AD

Path CB

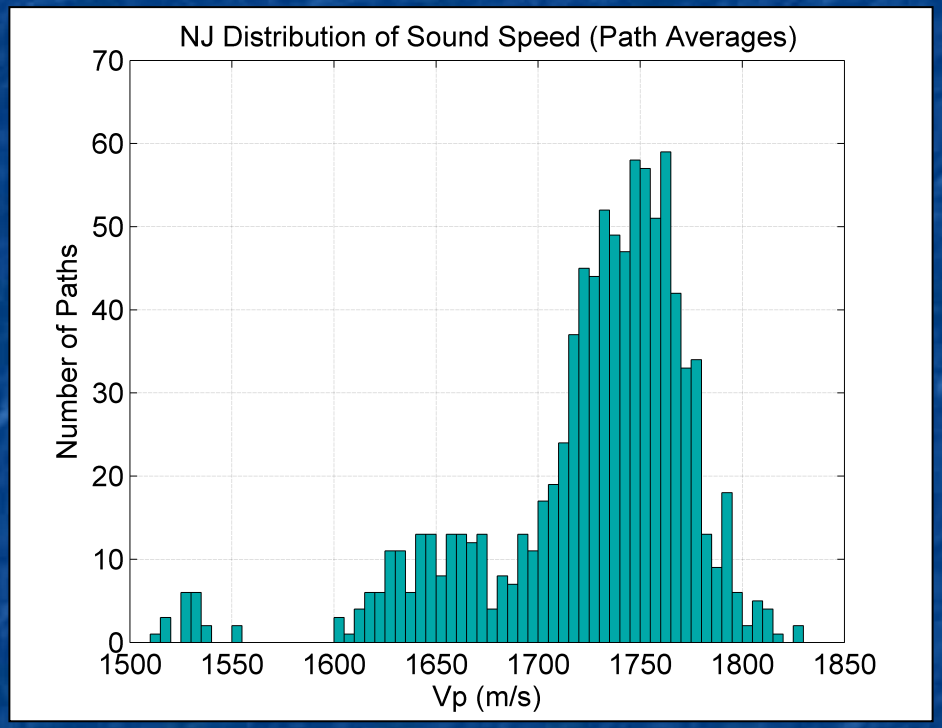
Path CD

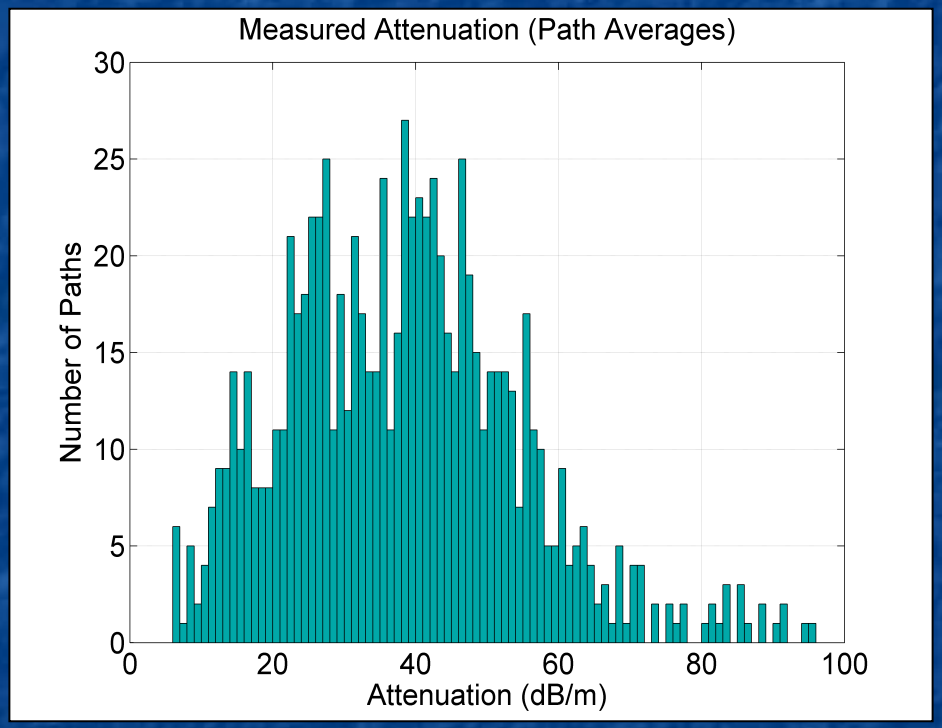
ONR Geoclutter Field Area




Geoclutter - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Layers
Attenuation
Sound Speed
Sediment Vp (m/s)
1786.1 - 1801.4
1770.7 - 1786.0
1755.3 - 1770.6
1740.0 - 1755.2
1724.6 - 1739.9
1709.2 - 1724.5
1693.8 - 1709.1
1678.4 - 1693.7
1663.0 - 1678.3
1647.6 - 1662.9
1632.2 - 1647.5
1616.9 - 1632.1
1601.5 - 1616.8
1586.1 - 1601.4
1570.7 - 1586.0
1555.3 - 1570.6
1539.9 - 1555.2
1524.4 - 1539.8
composite
corridor2
corridor_mos2
composite_mos
Display
Source
NJ Sediment Sound Speed (m/s)
• Stations selected to represent a range of BS types
• Few stations in Hudson Apron
8143875.28 4376265.77 Meter:

Geoclutter Field Area Surficial Variability

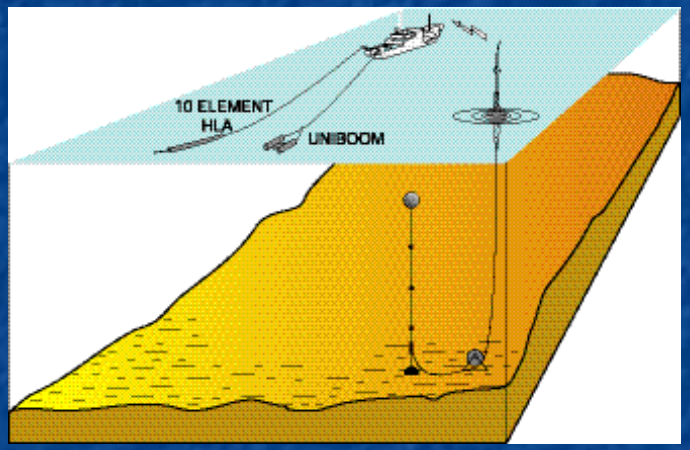




Reflection: WARBLE
High resolution geoacoustic inversion

Addresses two main problems in geoacoustic inversion

- uniqueness problem
- initial parameterization
  how many layers?)



Measurement approach:

- high spatial sampling on “local” scales
- single phone; broadband source
  (100 – 10,000 Hz)

Inversion Strategy

1. use space-time domain data to determine initial parameterization and bound the velocity model
2. use space-frequency domain data (reflection loss) to refine velocity and extract density/attenuation;
3. use time domain data for final refinements

[1] Holland, C. W. and Osler, J., “High-resolution geoacoustic inversion is shallow water: A joint time- and frequency-domain technique,” J. Acoust. Soc. Am., **107,** 1263-1279 (2000)

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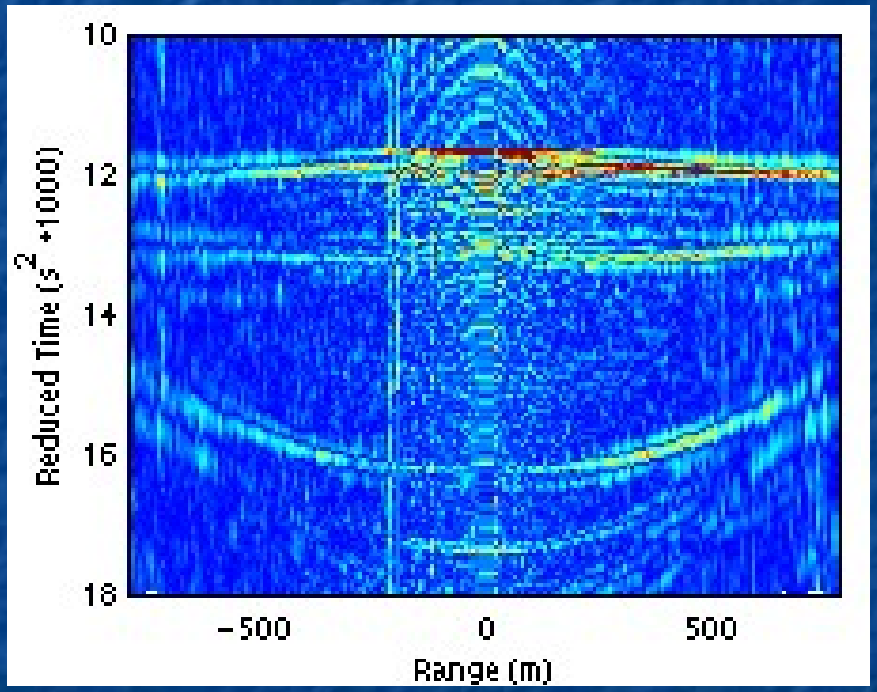
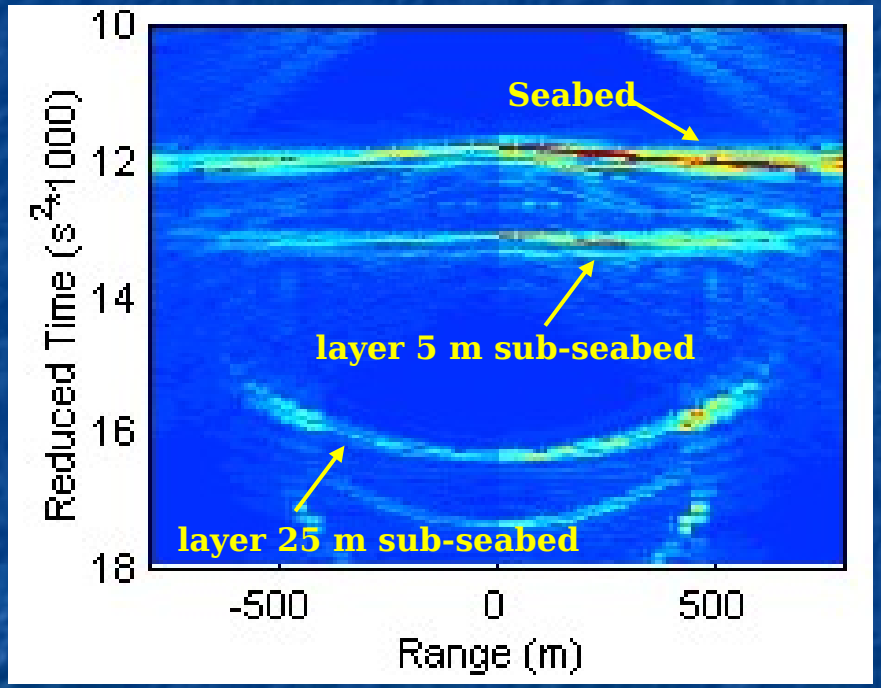
Synthetic Seismograms

Measured Broadband Data

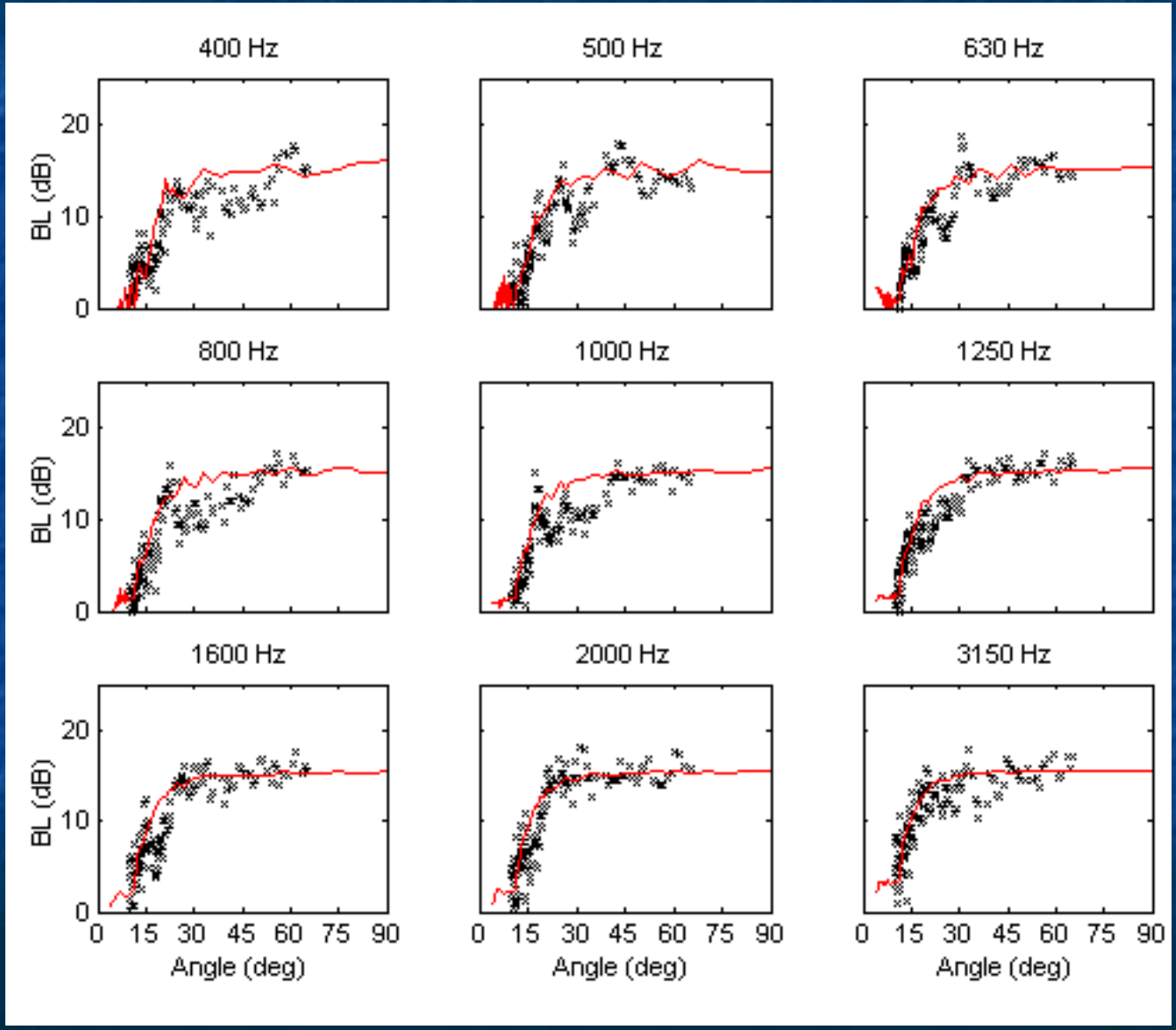


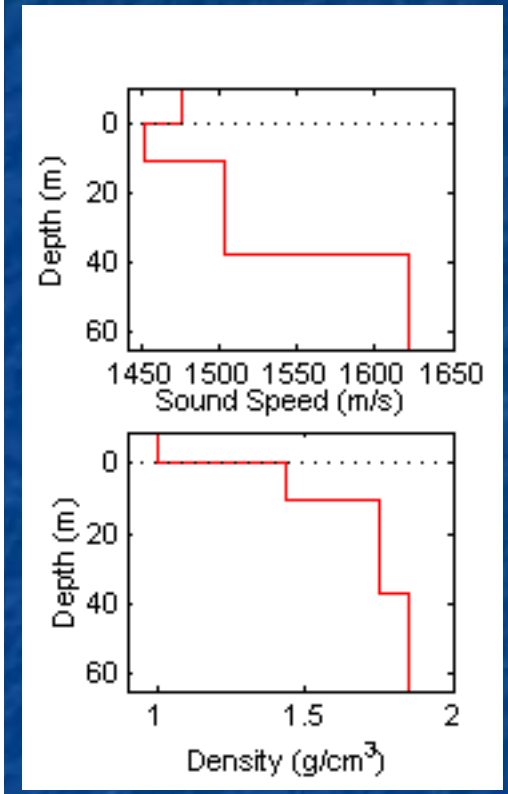
Modeled Broadband Data



Space-time domain data gives initial velocity model

Frequency Domain (Reflection Loss)





Reflection loss analysis used to refine velocity model and obtain density and attenuation

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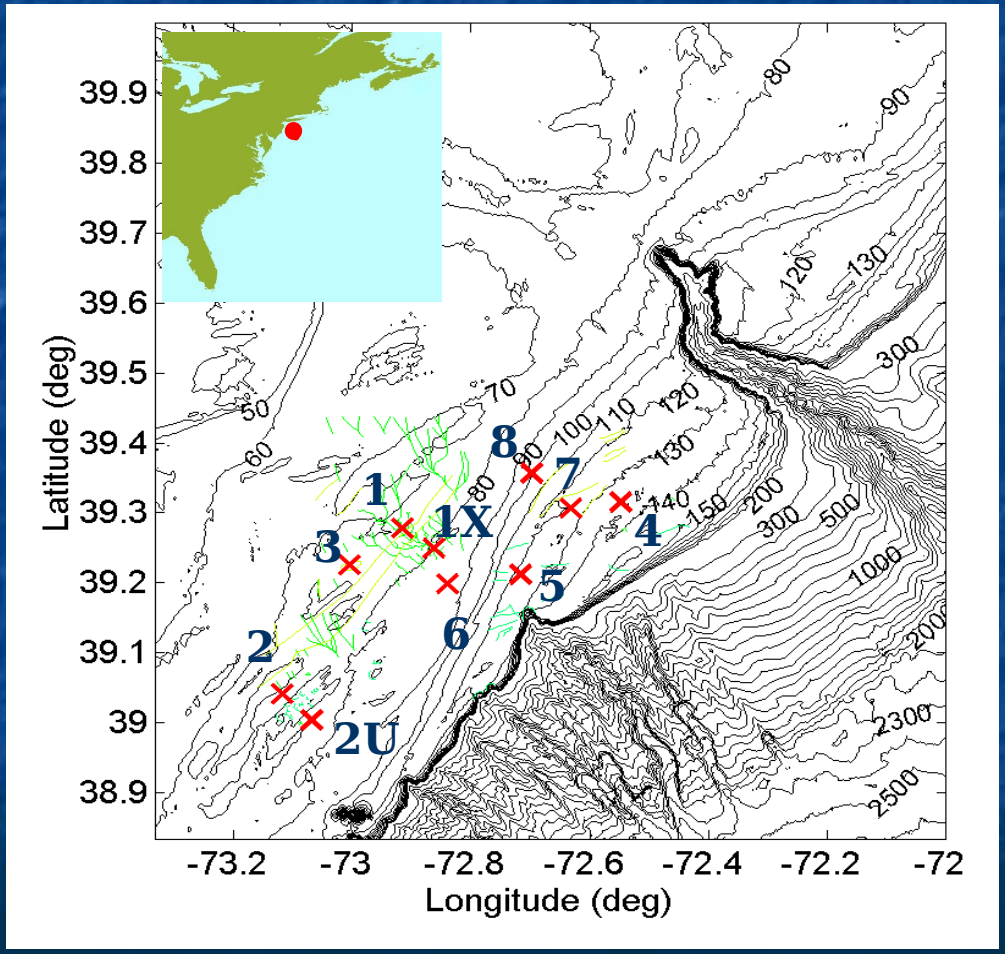
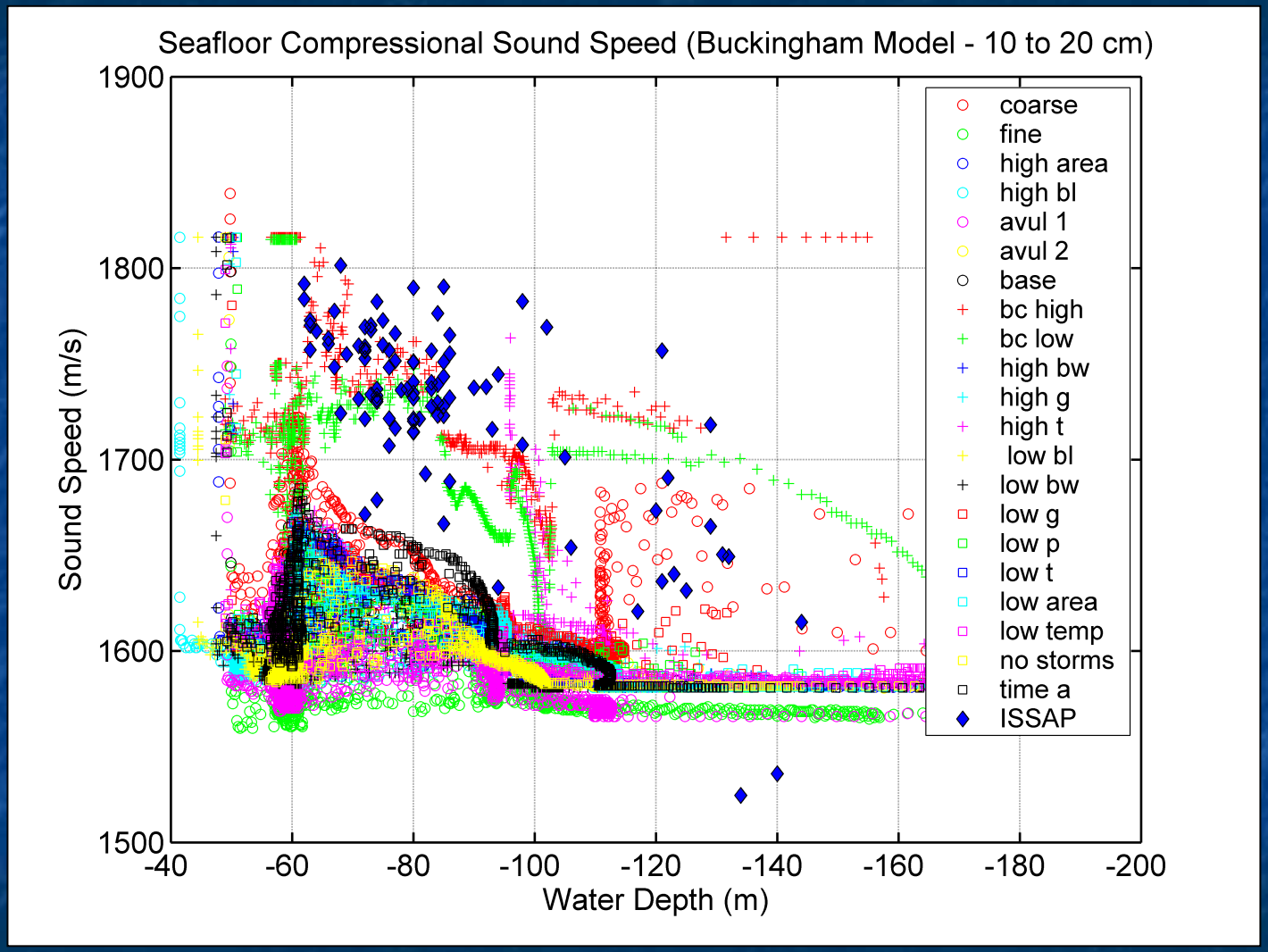
Boundary01 Reflection/Scattering

New Jersey Shelf

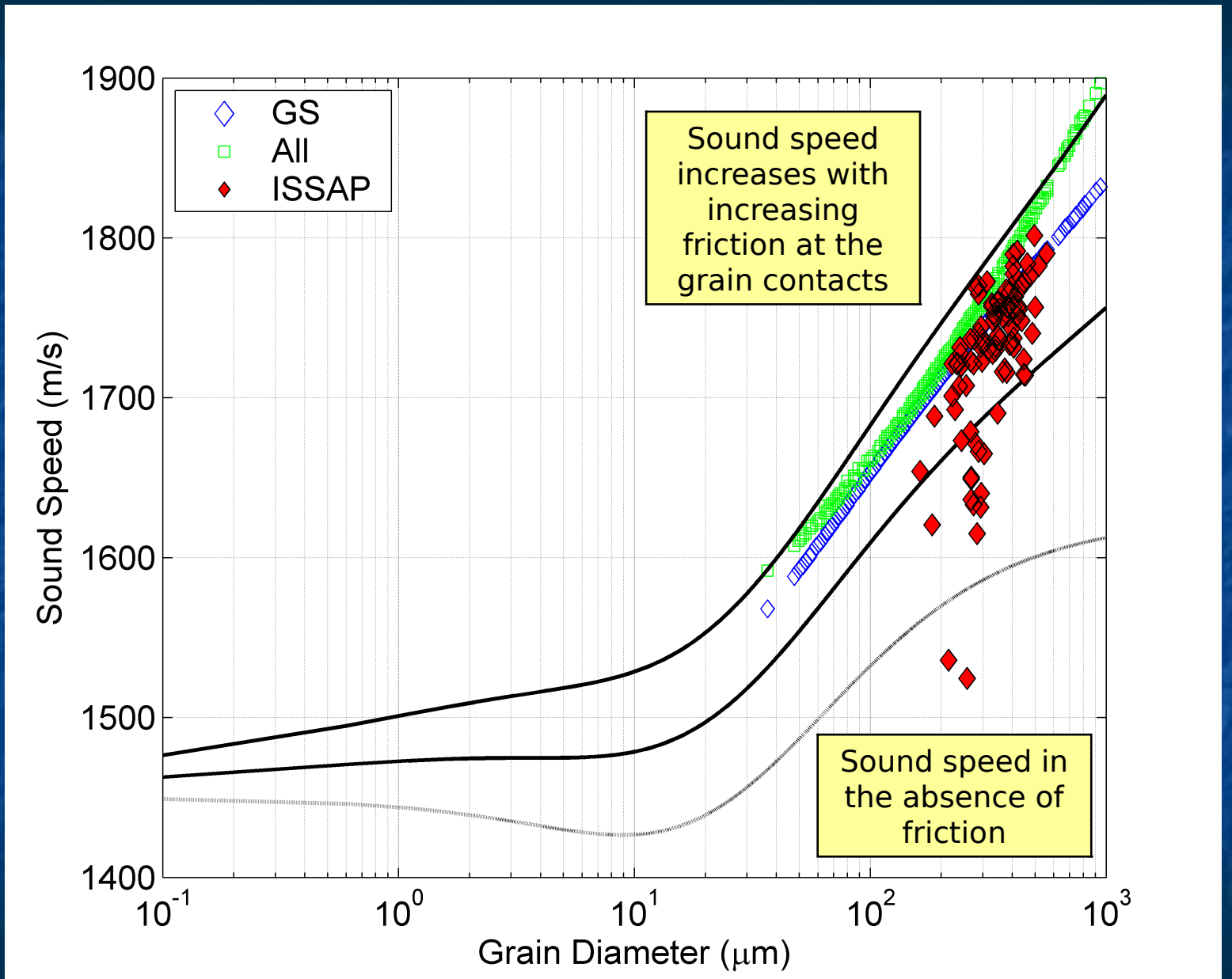


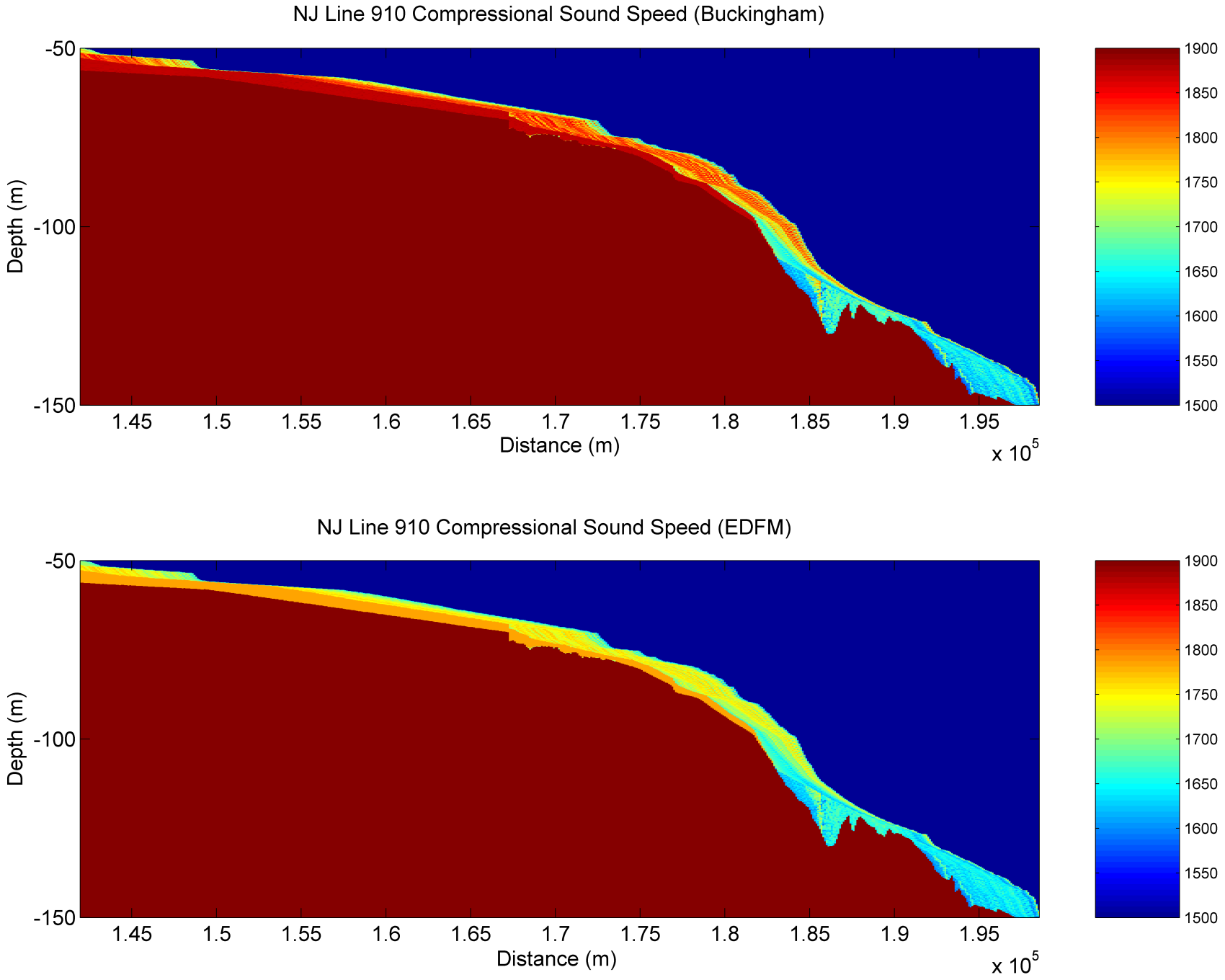
Water depths 75-137 m

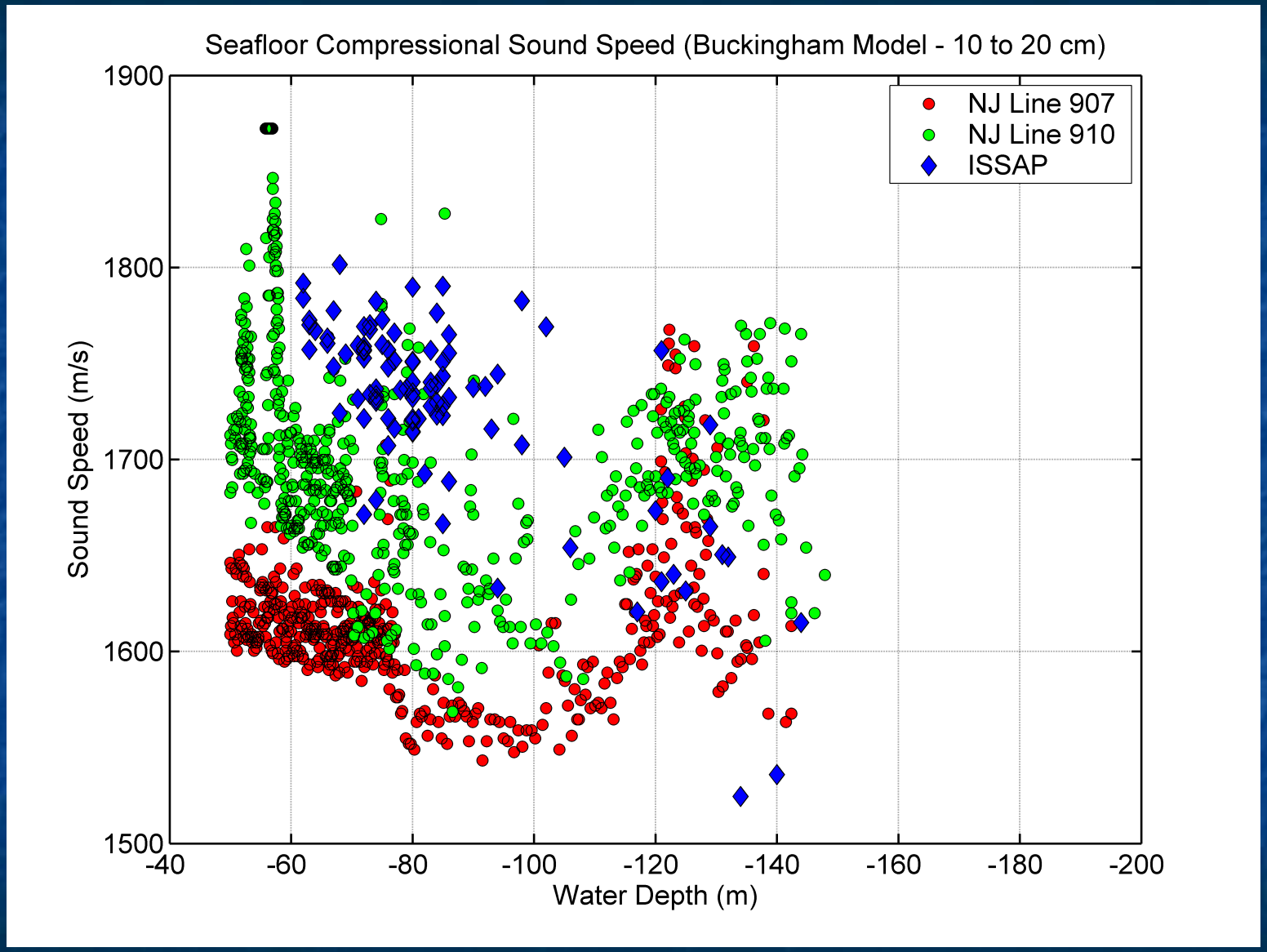
SedFlux Comparison to Surficial Data



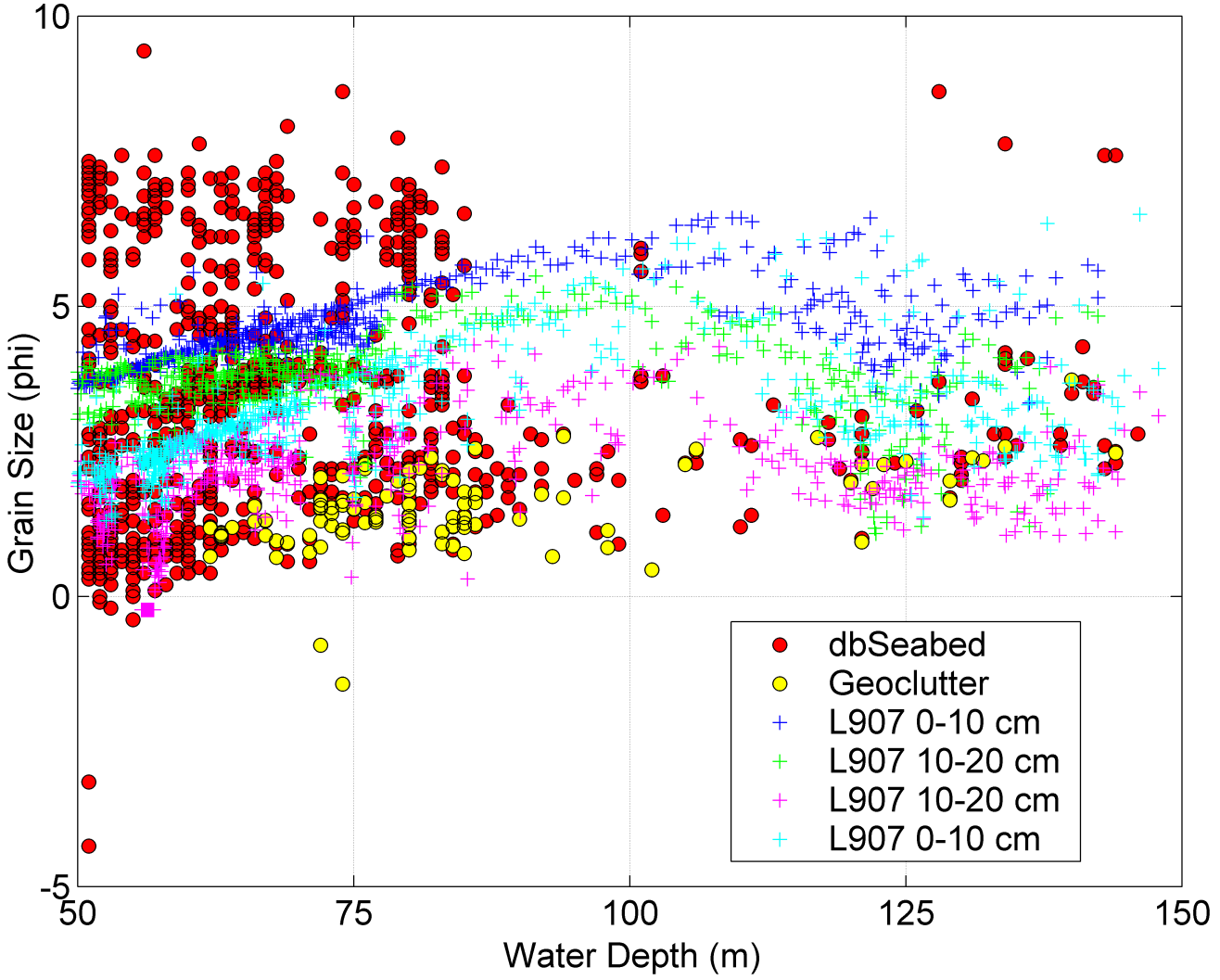
ISSAP measurements at depth of 10 to 15 cm
Correlated with SedFlux predictions by water depth


GS
All
ISSAP
Sound speed increases with increasing friction at the grain contacts
Sound speed in the absence of friction
Sound Speed (m/s)
Grain Diameter (μm)
1900
1800
1700
1600
1500
1400
10^-1
10^0
10^1
10^2
10^3


NJ Line 910 Compressional Sound Speed (Buckingham)
Depth (m)
-50
-100
-150
1.45
1.5
1.55
1.6
1.65
1.7
1.75
1.8
1.85
1.9
1.95
Distance (m)
x 10^5
1900
1850
1800
1750
1700
1650
1600
1550
1500
NJ Line 910 Compressional Sound Speed (EDFM)
Depth (m)
-50
-100
-150
1.45
1.5
1.55
1.6
1.65
1.7
1.75
1.8
1.85
1.9
1.95
Distance (m)
x 10^5
1900
1850
1800
1750
1700
1650
1600
1550
1500

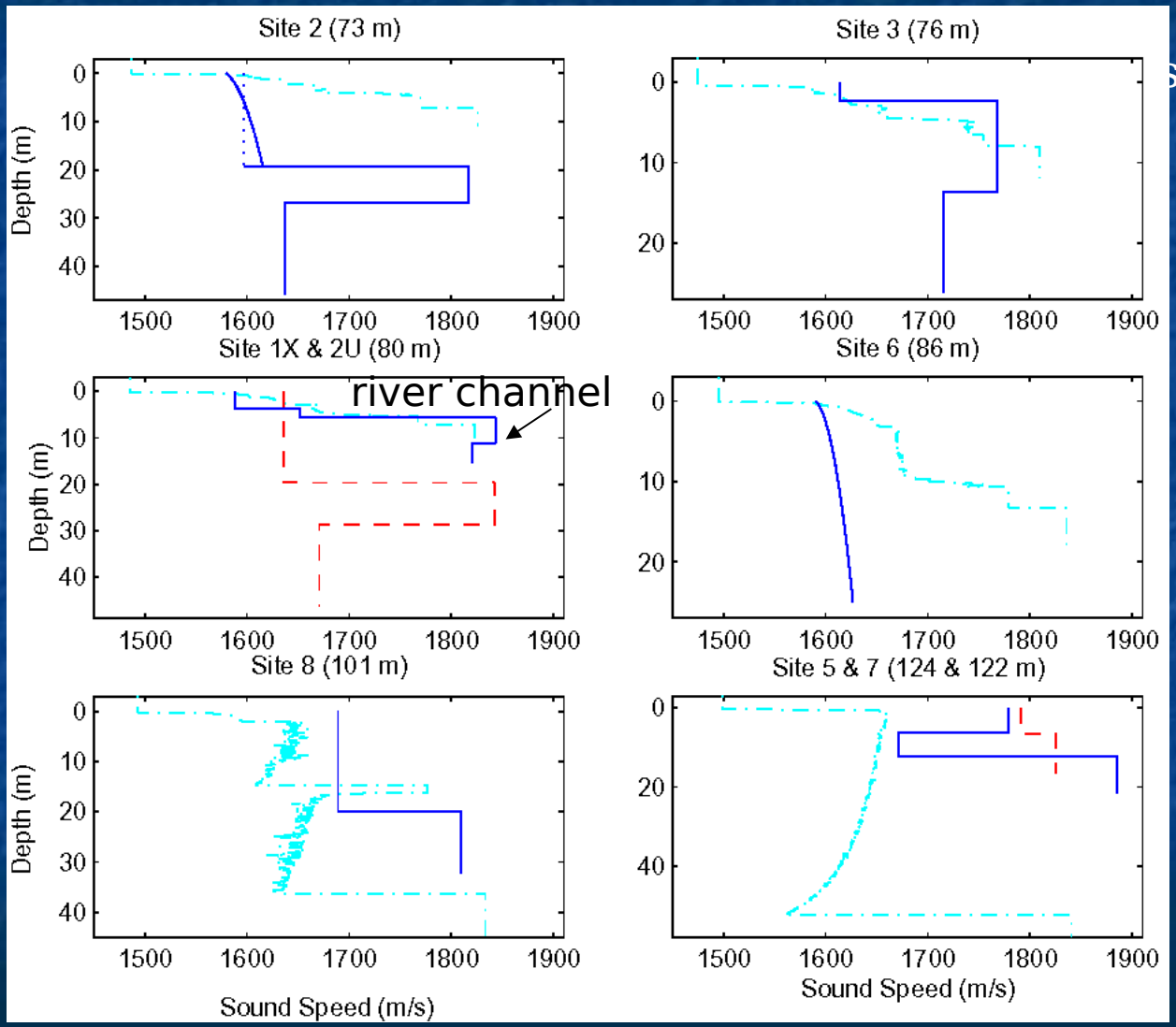

Seafloor Compressional Sound Speed (Buckingham Model - 10 to 20 cm)
NJ Line 907
NJ Line 910
ISSAP
Sound Speed (m/s)
1900
1800
1700
1600
1500
-40
-60
-80
-100
-120
-140
-160
-180
-200
Water Depth (m)

Grain size (mm)



dbSeabed data courtesy of Chris Jenkins, INSTAAR

SedFlux Comparison



SedFlux

Measured

- WARBLE velocities have an uncertainty of ~1-2%
- SedFlux predicts velocities generally too high for WD<100m
- SedFlux predicts velocities generally too low for WD<100m

Interim Conclusions

- SedFlux geoacoustic uncertainty is large due to uncertainty in paleo-inputs
- Some of the uncertainty (±50-100 m/s) comes from the relationship between mean grain size and velocity
- First comparisons of SedFlux with measured geoacoustic data indicate that:
  - surficial grain sizes and thus velocities are generally too low
  - from 0.5-20 m sub-bottom
    - WD < 100m; velocities are generally too high
    - WD 100-125 m; velocities are generally too low
- New Jersey shelf not an ideal place to exercise present version of SedFlux
  - model emphasizes river deposition
  - shelf highly reworked by waves and currents
- Substantial along shelf variability underscores need for 3D model